Hamakua Marsh (Kailua, Oʻahu) restoration site - 2011 plant monitoring survey

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Introduction

This report is the third monitoring report for a wetlands restoration project at Hamakua Marsh, Kailua, windward Oʻahu (see Fig. 1). The purpose of this report is to document progress towards a wetland restoration that began in April-May 2008 as measured by the results of vegetation transects undertaken approximately three years following restoration. Restoration and monitoring requirements are detailed in a Removal/Restoration Plan (SWCA, 2006) in compliance with agreements reached with the U.S. Environmental Protection Agency (EPA) arising from Docket No. CWA-404-309 (a)-06-007 (EPA, 2006) for placing fill material in a wetland located on property owned by Kaneohe Ranch Company.

The restoration site is located on a triangular parcel (TMK: 4-2-003:29) adjacent to Kawai Nui Stream ("Hamakua" Stream in some sources) and is part of the Kaelepulu-Hamakua drainage canal (Fig. 1). Because some of this area was previously a wetland along a drainage channel and fill was placed without a Dept. of the Army permit, restoration back to wetland conditions was required by EPA.

Survey Methods

To date, five separate plant surveys have been conducted at the Hamakua Marsh restoration site. An initial survey made in May 2008 produced a non-

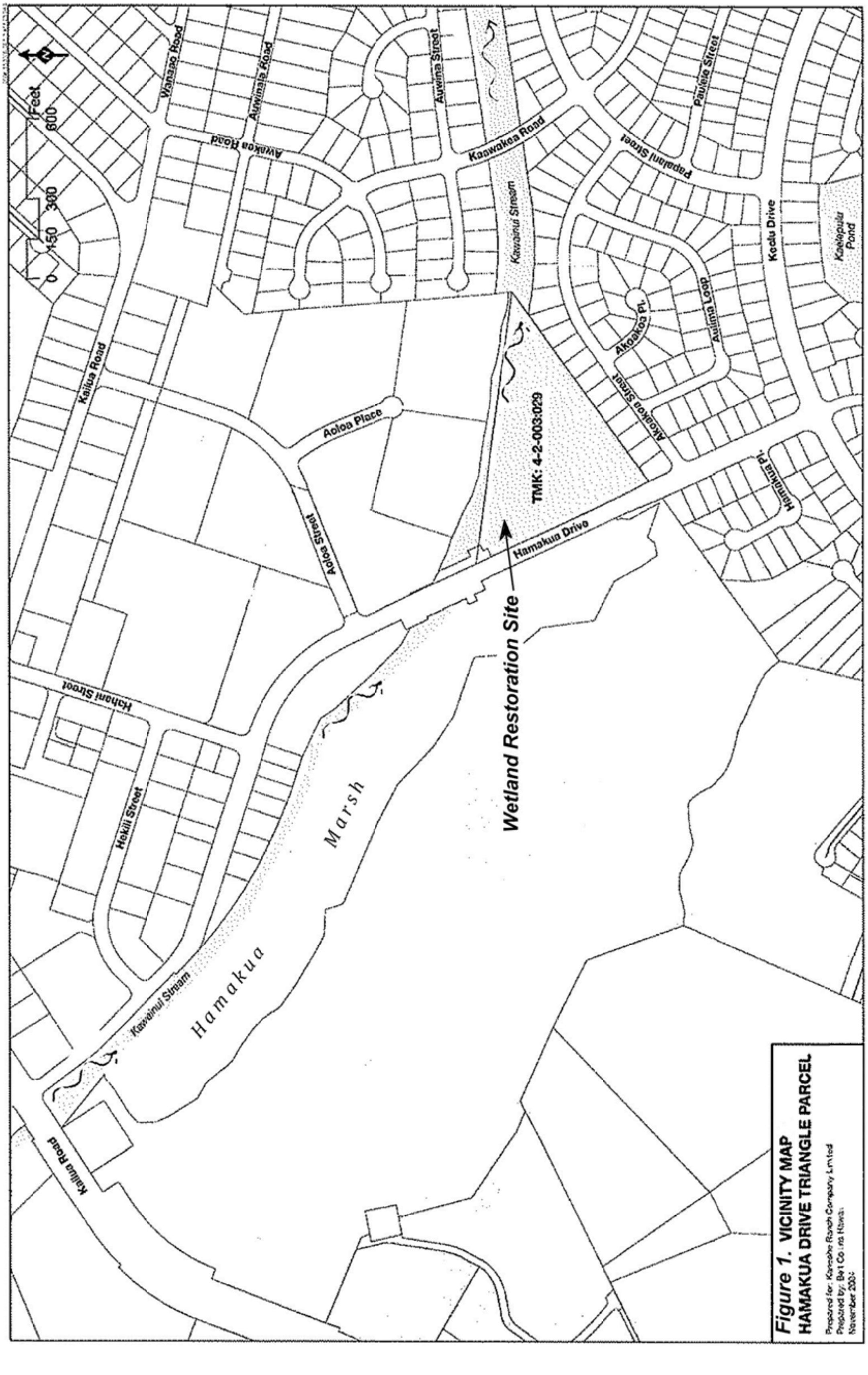

Figure 1. VICINITY MAP
HAMAKUA DRIVE TRIANGLE PARCEL

quantitative listing of plants representing conditions during the early stage of physical alteration (regrading) of the site. This species list is given in *AECOS* (2009). *AECOS* undertook a second quantitative (transect) survey on September 22, 2008. Although representing post-restoration conditions, most of the plantings that had been made in June and August of 2008 had failed to survive. Additional plantings were then made throughout November 2008 (Matt Schirman, Hui Kū Maoli Ola, pers. comm.). Consequently, *AECOS* undertook a third plant survey on April 14, 2009. Plantings had by this time taken hold and this survey constituted the first "official" monitoring of the restoration effort (*AECOS*, 2009). A second-year post-construction survey was conducted on June 25, 2010 (AECOS, 2010); the results of the third post-construction survey undertaken on August 5, 2011 are presented here.

For the April 2009 and June 2010 surveys, vegetation abundance data were obtained from two transects laid along the south and west margins of the restored depression. Transect placements were limited to the margins of the restored area because very few plants were growing within the more central shallow pond and mud flat. While these data documented the success of plantings in specific areas, the results could not be meaningfully extended to the wetland as a whole. However, the vegetation cover changed radically in the 12 months after June 2010. Although approximately the southern half of the wetland remains an unvegetated, very shallow pond, vegetation now surrounds the pond and the former bare mud flat in the northern half is now covered over with a variety of wetland species (Fig. 2). This change in the development of the vegetation prompted a need to alter the sampling approach to one covering the wetland area as a whole rather than just the margins.

For the August 2011 survey, five positions were located along the eastern shore where representative transects could be laid out across the wetland. A central base point was selected and then two base points to the north and two base points to the south were established, each base point being roughly 10 m (30 ft) apart. From each of the five base points on the eastern shore, a transect line was played out across the marsh to the western edge where there remains a staked geotextile fabric barrier marking the project area boundary.

An aluminum quadrat frame of dimensions 1.0 by 0.5 m, outfitted with a grid of heavy sugi thread spaced at 10 cm intervals, was used to quantify plant cover along the transects. The quadrat frame was placed on each side of the transect line creating a quadrat of dimensions 0.5 x 2.0 m (1 m^2). The quadrat placement position along a line was determined by a position table constructed in advance. Three different tables were used, with 1 No/1 So and 2 No/2 So sharing tables). Each position table listed 5 randomly determined placements from the 20 possible placements in each 10-m section of the line. This stratified random

approach established a fairly even coverage across the entire marsh, while reducing or eliminating bias in actual placement of the frame.

Figure 2. August 2011 view across central part of the wetland showing transect line laid out at Transect Mid. Base point is a surveyor's arrow set in the *'ahu'awa* plants in the foreground.

Once the quadrat frame was placed in position, a biologist considered each of the 50 10 x 10 cm squares and recorded the dominant (covering 50% or greater) plant species (or substratum = "plant cover <50%") within a square. The result of these counts is then an estimate of the percent coverage for each species within a quadrat, where each scoring represents 1% (1/100) of the 1 m^2 quadrat area. This method was used to examine 104 stratified random 1 m^2 quadrats distributed over the restoration marsh. Unlike previous surveys (*AECOS*, 2009, 2010), the margins of the marsh are only a small portion of the transect sampling area and not sampled in most of the transects).

Results

Quadrat counts from the August 5, 2011 transects are summarized in Table 1 as percent cover by survey category. Quadrat data from the 2011 survey are presented in Appendix A.

Table 1. Results (% cover) of post-construction plant cover for August 5, 2011 survey across the Hamakua Marsh restoration site.

	2 So	1 So	MID	1 No	2 No
BARE SUBSTRATUM (Dry or exposed mud)	27.3	21.4	43.7	7.5	22.5
WATER OVER BARE SUBSTRATUM (Flooded)	72.7	41.7	--	--	--
WETLAND PLANTS					
Cyperus javanicus (*ʻahuʻawa*)	--	11.7	--	1.6	0.6
Bacopa monieri (*ʻaeʻae*)	--	3.5	1.8	23.2	3.0
Bolboschoenus maritimus (*kaluhā*)	--	--	0.4	10.8	2.7
Rhizophora mangle (mangrove)*	--	4.0	2.3	2.1	1.2
Batis maritima (pickleweed)*	--	17.3	51.8	55.4	66.0
WETLAND MARGIN PLANTS					
Pluchea indica (Indian fleabane)*	--	--	--	--	1.5
UPLAND PLANTS					
Asystasia gangetica (Chinese violet)*	--	0.4	--	--	--
Scaevola taccada (*naupaka kahakai*)	--	--	--	--	2.8

* indicates non-native species

Conclusions

The purpose of the vegetation monitoring is to confirm that a wetland with certain wetland values—one being the presence of emergent vegetation—has been established by the restoration efforts. Quantifying vegetation cover by species is the most practical way to interpret whether a wetland has become established and restoration goals have been met. The site has been physically restored, plantings made, and much of the site populated by emergent herbaceous and woody vegetation surviving and spreading from these plantings. However, natural recruitment from adjacent wetland areas is also a significant factor in determining the nature of the vegetation of this wetland.

In general terms, plant cover as of August 2011 can be described as substantial in the northern half of the restoration area (see Fig. 3), with roughly 15% of the

Figure 3. Northern portion of the Hamakua Marsh restoration site as it appeared in August 2011; view is along Transect 1 No.

Figure 4. Southern pond area of the Hamakua Marsh restoration site as it appeared in August 2011; view is along Transect 2 So.

area lacking vegetation (Table 1, combining results from transects 1 No and 2 No). This condition differs considerably from that observed by our previous survey in June 2010, when bare substratum characterized a majority of the marsh area except along the very margins of the graded basin. However, the southern portion of the wetland remains a large pond (presumably with variable water level; see Fig. 4, above) and is likely to remain in this condition for some time, although there are indications of wetland vegetation invading the south and west shores. This open-water feature is attractive to *A'eo* or Hawaiian stilt (*Himantopus mexicanus knudseni*).

Unlike previous surveys where placing transects across the basin would have found little vegetation, the August 2011 transects were set across the basin from roughly east to west and thus representative of the site as a whole. Based on all five transects, vegetation cover is now 52.2% of the marsh area.

The vegetation present at the Hamakua Marsh restoration site includes a number of native species, the most abundant being *'ae'ae* (*Bacopa monieri*) at 7.5% of the marsh area. Two other native species—*kaluhā* (*Bulboschoenus maritimus*) at 3.5% overall, and *'ahu'awa* (*Cyperus javanicus*) at 3.2% cover—are conspicuous. However, the dominant vegetation at this site is now pickleweed or *'akulikuli kai* (*Batis maritima*) at 34.8% cover. This non-native shrub and red mangrove (*Rhizophora mangle*) are the dominant species in Hamakua Marsh generally. Although mangrove is presently only 2.5% of the restoration site, the mangrove plants are mostly saplings (in 2010, most were rooted seedlings). Mature mangrove trees line the western edge of the restoration area just outside the boundary (see Fig. 5).

References

AECOS, Inc. (*AECOS*). 2009. Hamakua Marsh (Kailua, O'ahu) restoration site, plant monitoring survey. Prep. for Bureau Veritas North America, Inc. *AECOS* No. 1174A: 20 pp.

_____. 2010. Hamakua Marsh (Kailua, O'ahu) restoration site, 2010 plant monitoring survey. Prep. for Bureau Veritas North America, Inc. *AECOS* No. 1174B: 23 pp.

SWCA Environmental Consultants (SWCA). 2006. Revised Hamakua Drive Wetland Removal & Restoration Plan, Kailua, Oahu, Hawaii, EPA Docket No. CWA-404-309 (a)-06-007.

Figure 5. Panoramic view at Transect 1 So looking across a portion of the southern pond (Transect 2 So being reeled-in on left). Trees in background are red mangrove lining the Kaelepulu-Hamakua drainage canal.

U. S. Environmental Protection Agency (EPA). 2006. Findings of Violation and Order for Compliance under Sections 308 and 309(a) of the Clean Water Act, EPA Docket No. CWA No. CWA-404-309(a)-06-007. April 24, 2006.

Appendix A

Quadrat Counts by Transect - August 5, 2011

TRANSECT 2 No

	Batis		‘Ae’ae		‘Ahu'awa		Kaluhā		Rhizophora		Naupaka		Pluchea		Bare sediment	
00+	1	18				5					16			2	33	25
05-		5	50	10			34									1
07-	38	47													12	3
08+	50	48														2
09+	50	49														1
10+	50	50														
12-	50	50														
13-	50	50														
15-	50	21														29
17+	22	8													28	42
21-	50	2						15								33
22-	50	1														49
23+	50	10														40
24-	10	9													40	41
25-	17	13													33	37
30+	50	50														
31-	50	50														
34-	50	50														
35-	50	50														
38-					4	2		4		24		39		3 24		
TOTAL	738	581	50	10	4	7	34	19	0	24	55	0	3	26	146	303
Percent	73.8%	58.1%	5.0%	1.0%	0.4%	0.7%	3.4%	1.9%	0.0%	2.4%	5.5%	0.0%	0.3%	2.6%	14.6%	30.3%

NOTE: Results for each quadrat are paired, reflecting the left and right sides (respectively) of the placement on the transect line.

TRANSECT 1 No

	Batis		‘Ae’ae		‘Ahu'awa		Kaluhā		Rhizophora		Naupaka		Pluchea		Bare sediment	
02+	15	45	29	3	6											2
03-	46	46	2						2	4						
03+	40	48			6				3						1	2
04+	49	50													1	
09+	20	25					30	6								19
10-	8	17					41	7							1	26
11-	28	20			19										3	30
12+	37	2			1				9						3	48
16-	21	49	27					1	1						1	
extra 16+																
17+	12	16	38	39				5								
20-	3	17	3	9			44	24								
21-	35	46					13	2							2	2
22-	16	8	24	40			10	2								
22+	8	6	35	20			7	23		1						
29+	47	49		1					3							
31+	49	50	1													
32-	41	46	3						6	2						2
32+	17	45	21						10						2	5
34-	9	11	40	39			1									
35-	6	5	44	45												
TOTAL	507	601	267	196	32	0	146	70	34	7	0	0	0	0	14	136
Percent	50.7%	60.1%	26.7%	19.6%	3.2%	0.0%	14.6%	7.0%	3.4%	0.7%	0.0%	0.0%	0.0%	0.0%	1.4%	13.6%

TRANSECT Mid

	Batis		‘Ae’ae		‘Ahu'awa		Kaluhā		Rhizophora		Naupaka		Pluchea		Bare sediment	
03+	45	50													5	
04+	37	45													13	5
05-	12	44													38	6
05+	3	35													47	15
08-	26	46													24	4
10+	50	43					4		3							
14+															50	50
16+															50	50
19-															50	50
19+															50	50
21+															50	50
26-	2	19					1								48	30
27-	17	40							3						33	7
27+	38	45	2						3						10	2
29+	19	50	31													
32+	48	48					2			2						
33+	37	44							13	6						
34-	40	49							10	1						
TOTAL	374	558	33	0	0	0	2	5	29	12	0	0	0	0	468	319
Percent	41.6%	62.0%	3.7%	0.0%	0.0%	0.0%	0.2%	0.6%	3.2%	1.3%	0.0%	0.0%	0.0%	0.0%	52.0%	35.4%

TRANSECT 1 So

	Batis		‘Ae’ae		‘Ahu'awa		Kaluhā		Rhizophora		Ch. violet		Bare flooded		Bare mud	
02+															50	50
03-															50	50
03+															50	50
04+															50	50
09+															50	50
10-													50	50		
11-													50	50		
12+													50	50		
16-													50	50		
17+													50	50		
20-													50	50		
21-													50	50		
22-													50	50		
22+													50	50		
29+													50	50		
31+	30	40	16	9						1					4	
32-	28	50	21												1	
32+	47	49							1						2	1
34-	48	47								1					2	2
35-	37	38				7			13	4						1
42-	1		3	30					47	19						
44+		1		5	50	43				1						
45-					45	48			1	2	4					
45+					37	50			7		6					
TOTAL	191	225	40	44	132	148	0	0	69	28	10	0	500	500	259	254
Percent	15.9%	18.8%	3.3%	3.7%	11.0%	12.3%	0.0%	0.0%	5.8%	2.3%	0.4%	0.0%	41.7%	41.7%	21.6%	21.2%

TRANSECT 2 So

	Batis		‘Ae’ae		‘Ahu'awa		Kaluhā		Rhizophora		Naupaka		Bare flooded		Bare mud	
00+															50	50
05-													50	50		
07-													50	50		
08+													50	50		
09+													50	50		
10+													50	50		
12-													50	50		
13-													50	50		
15-													50	50		
17+													50	50		
21-													50	50		
22-													50	50		
23+													50	50		
24-													50	50		
25-													50	50		
30+													50	50		
31-													50	50		
34-															50	50
35-															50	50
38-															50	50
40-															50	50
41+															50	50
22																
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	800	800	300	300
Percent	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	72.7%	72.7%	27.3%	27.3%